

What is claimed is:

1. A method of manufacturing a semiconductor device comprising:

5 (a) forming a groove on a first surface of a semiconductor substrate, a plurality of integrated circuits and electrodes being formed on the first surface;

(b) forming an insulating layer on an inner surface of the groove;

(c) forming a first conductive layer on the insulating layer on the inner surface of the groove;

10 (d) grinding a second surface of the semiconductor substrate opposite to the first surface until the groove is exposed to divide the semiconductor substrate into a plurality of semiconductor chips each of which has a first conductive layer exposed on a side surface of each of the semiconductor chips;

(e) stacking the semiconductor chips; and

15 (f) electrically connecting the first conductive layer of one of the semiconductor chips with the first conductive layer of another one of the semiconductor chips.

2. The method of manufacturing a semiconductor device as defined in claim 1,

20 wherein the insulating layer is continuously formed from the inner surface of the groove to the first surface in the step (b).

3. The method of manufacturing a semiconductor device as defined in claim 1,

25 wherein the first conductive layer is continuously formed from the inner surface of the groove to the first surface in the step (c).

4. The method of manufacturing a semiconductor device as defined in claim 1,

wherein the first conductive layer is electrically connected to one of the

electrodes in the step (c).

5. The method of manufacturing a semiconductor device as defined in claim 1,
wherein the semiconductor chips are stacked so that the first surfaces of the
5 semiconductor chips on which the electrodes are formed are oriented to the same
direction in the step (e).

6. The method of manufacturing a semiconductor device as defined in claim 1,
wherein the semiconductor chips are stacked so that the first surface of one of
10 the semiconductor chips on which the electrodes are formed is oriented opposite to the
first surface of another one of the semiconductor chips on which the electrodes are
formed in the step (e).

7. The method of manufacturing a semiconductor device as defined in claim 1,
15 wherein the step (e) includes providing at least one insulator between the
semiconductor chips.

8. The method of manufacturing a semiconductor device as defined in claim 7,
wherein the insulator projects from side surfaces of the semiconductor chips in
20 the step (e).

9. The method of manufacturing a semiconductor device as defined in claim 1,
wherein the step (f) includes forming a second conductive layer which
electrically connects the first conductive layers on a side surface of at least one of the
25 semiconductor chips.

10. The method of manufacturing a semiconductor device as defined in claim 9,

wherein the second conductive layer is extended in a direction perpendicular to the semiconductor chip in order to electrically connect the first conductive layers of the semiconductor chips which are stacked straight in the step (f).

5 11. The method of manufacturing a semiconductor device as defined in claim 9,
 wherein the second conductive layer has a portion extending in a direction
 parallel to the semiconductor chips in order to electrically connect the first conductive
 layers of the semiconductor chips which are irregularly stacked in the step (f).

10 12. The method of manufacturing a semiconductor device as defined in claim 8,
 wherein the step (f) includes forming a second conductive layer which
 electrically connects the first conductive layers on a side surface of at least one of the
 semiconductor chips;

 wherein the second conductive layer has a portion extending in a direction
15 parallel to the semiconductor chips in order to electrically connect the first conductive
 layers of the semiconductor chips which are irregularly stacked in the step (f); and

 wherein a part of the second conductive layer is formed on the projecting
 portion of the insulator.

20 13. The method of manufacturing a semiconductor device as defined in claim 9,
 wherein the second conductive layer is formed of a solder in the step (f).

 14. The method of manufacturing a semiconductor device as defined in claim 9,
 wherein the second conductive layer is formed by supplying a solvent
25 containing conductive particles in the step (f).

15. The method of manufacturing a semiconductor device as defined in claim 1,

further comprising, at least after the step (d):

(g) mounting the semiconductor chips on a substrate; and

(h) electrically connecting the semiconductor chips to an interconnecting pattern of the substrate.

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16. The method of manufacturing a semiconductor device as defined in claim 15, wherein the steps (e) and (g) are performed before the steps (f) and (h).

17. The method of manufacturing a semiconductor device as defined in claim 15, wherein a solder is used to electrically connect the first conductive layers to the interconnecting pattern in the step (h).

18. The method of manufacturing a semiconductor device as defined in claim 15, wherein the first conductive layers are electrically connected to the interconnecting pattern by supplying a solvent containing conductive particles in the step (h).

19. A semiconductor device manufactured by the method as defined in claim 1.

20. A semiconductor device comprising:
a plurality of stacked semiconductor chips, each of which has a first surface on which an integrated circuit and electrodes are formed;
an insulating layer continuously formed from the first surface to a side surface of each of the semiconductor chips;
a first conductive layer formed on the insulating layer on the side surface of each of the semiconductor chips; and
a second conductive layer electrically connecting the first conductive layer of

one of the semiconductor chips to the first conductive layer of another one of the semiconductor chips,

wherein part of the side surface of each of the semiconductor chips is covered only by the insulating layer; and

5 wherein the second conductive layer is formed on the side surface of at least one of the semiconductor chips.

21. The semiconductor device as defined in claim 20,
 wherein the first conductive layer is continuously formed from the side surface
10 of the semiconductor chip to the first surface.

22. The semiconductor device as defined in claim 20,
 wherein the first conductive layer is electrically connected to one of the electrodes.
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23. The semiconductor device as defined in claim 20,
 wherein the semiconductor chips are stacked so that first surfaces of the semiconductor chips on which the electrodes are formed are oriented to the same direction.
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24. The semiconductor device as defined in claim 20,
 wherein the semiconductor chips are stacked so that the first surface of one of the semiconductor chips on which the electrodes are formed is oriented opposite to the first surface of another one of the semiconductor chips on which the electrodes are
25 formed.

25. The semiconductor device as defined in claim 20,

wherein at least one insulator is provided between the semiconductor chips.

26. The semiconductor device as defined in claim 25,
wherein the insulator projects from side surfaces of the semiconductor chips.

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27. The semiconductor device as defined in claim 20,
wherein the second conductive layer is extended in a direction perpendicular to
the semiconductor chip in order to electrically connect the first conductive layers of the
semiconductor chips which are stacked straight.

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28. The semiconductor device as defined in claim 20,
wherein the second conductive layer has a portion extending in a direction
parallel to the semiconductor chips in order to electrically connect the first conductive
layers of the semiconductor chips which are irregularly stacked.

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29. The semiconductor device as defined in claim 26,
wherein the second conductive layer has a portion extending in a direction
parallel to the semiconductor chips in order to electrically connect the first conductive
layers of the semiconductor chips which are irregularly stacked; and

20 wherein a part of the second conductive layer is formed on the projecting
portion of the insulator.

30. The semiconductor device as defined in claim 20,
wherein the second conductive layer is formed of a solder.

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31. The semiconductor device as defined in claim 20,
wherein the second conductive layer is formed by a solvent containing

conductive particles.

32. The semiconductor device as defined in claim 20, further comprising:

a substrate on which an interconnecting pattern is formed,

5 wherein each of the semiconductor chips is mounted on the substrate and electrically connected to the interconnecting pattern by the first conductive layers.

33. The semiconductor device as defined in claim 20,

wherein the semiconductor chips have approximately the same size.

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34. The semiconductor device as defined in claim 20,

wherein one of the semiconductor chips has a size different from a size of another one of the semiconductor chips.

15 35. A circuit board on which the semiconductor device as defined in claim 20 is mounted.

36. An electronic instrument comprising the semiconductor device as defined in claim 20.

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